Work and Power

Work W=Fd if F is in the direction of d
units: Joule, J = Nm = kgm^2/s^2
work is a scalar - can be negative if F is opposite d but doesn't have direction itself

Power, P is rate of doing work
P=W/t
units: Watts, W=J/s = kgm^2/s^3
Power is also a scalar

1. A 50.0 kg student runs up 23 stairs, 0.12 m high and 0.24m wide in 2.5s. Determine

a) the weight of the student
b) the distance up the stairs
c) the distance sideways of the stairs
d) the work done by the student against gravity
e) the work done by gravity
f) the work done by the normal force
g) the power of the student in Watts, and in horsepower 1hp = 746W

2. You leave a 100W light bulb on for 8.0 hours a day for a year. If BC Hydro charges $0.12 per kilowatt-hour

a) how much energy did you use in kilowatt-hours? In Joules?

b) How much does it cost to light the bulb? What if you used a high efficiency bulb, P=25W for the same brightness?

3. run up the stairs and calculate your power measure: Mass____, time____, height of each stair____ x the number of stairs____

Quiz Solutions:

1a) p=mv = 0.12 or 0.18kg x 15m/s =1.80kgm/s or 2.7kgm/s

b) Δp=pf-pi=m(vf-vi)=m(14-15)= -kgm/s or -0.18kgm/s0.12

c) Δp=pf-pi = mvf-mvi = -1.80kgm/s or -2.7kgm/s

d) Δp=pf-pi = m(vf-vi)= m(-14-15) = -3.4kgm/s or -5.2kgm/s

e) Fnet = Δp/Δt = -3.4 or -5.2/0.020s = -170N or -260N

2. a) total momentum before the explosion = total momentum after

$0=m_a v_a + m_b v_b$

$v_b = -m_a v_a /mb$ = -1.3m/s or -1.6m/s

1.3m/s opposite the other cart

b) F=Δp/Δt internal force between the carts, so just look at one cart

F= 3kg x 1.3m/s/0.20s = 2kg x 2m/s/0.02s = 20N

F= 5kg x 1.6m/s/0.20s = 2kg x 4m/s/0.02s = 40N

3. total momentum before = total momentum after
   0.035kgx350m/s + 0 =(0.035kg + 0.35 or 0.45kg)v
   v = 25.3 m/s or 31.8m/s

4. FΔt=Δp = area under the F-t graph
   85Nx20s= 1700Ns = mvf-mvi
   vf = [1700Ns + (4or 3kgx14m/s)]/4or3kg
   439m/s or 581m/s
   $4.4x10^2$m/s or $5.8x10^2$m/s

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